REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**199-8223**
SRP Section:	**03.08.01 - Concrete Containment**
Application Section:	**03.08.01**
Date of RAI Issue:	**09/08/2015**

Question No. 03.08.01-11

Appendix A to 10 CFR Part 50, General Design Criteria 1, 2, 4, 16 and 50, provide the regulatory requirements for the design of the concrete containment. Standard Review Plan (SRP) 3.8.1, Section II discusses the applicable codes, standards and specifications, regulatory requirements, and regulatory guides applicable to the design of the concrete containment.

The containment structure, including the basemat directly beneath the containment is integral with the auxiliary building (AB) basemat. The staff noted that Section 3.8.1 of the DCD Tier 2 does not describe the jurisdictional boundary for design of the containment in accordance with ASME Section III, Division 2, Subsection CC. In accordance with Appendix A to 10 CFR Part 50, General Design Criteria 1, 2, 4, 16 and 50, and SRP 3.8.1, the applicant is requested to identify the jurisdictional boundary of the containment for design in accordance with ASME Section III, Division 2 Code, and describe what aspects of the design incorporates additional design requirements beyond the portion of the containment foundation directly beneath containment shell. In addition, the applicant is requested to update Section 3.8.1 of the DCD Tier 2 accordingly.

Response - (Rev. 1)

APR1400 has a mat foundation of reinforced concrete referred to as nuclear island (NI) common basemat for the reactor containment building (RCB) and the auxiliary building (AB) areas. The NI common basemat has variable thickness according to the arrangement of structures, systems, and components. The thickness of the AB foundation is 10 feet, and that of the RCB varies from 23 feet to 33 feet, except for the portions of tendon gallery and reactor cavity area.

The design basis of the RCB and AB foundations conform to the requirement of ASME Section III, Division 2, Subsection CC and ACI 349 codes, respectively. The boundary of jurisdiction between the ASME and the ACI codes is as shown in Figure 1. The common basemat is

divided into two parts by code jurisdiction at the thickness transition interface, and it is a logical choice based on the physical configuration and functional requirements of the basemat.

In the APR1400 design, the anchoring of the containment shell reinforcement is limited within the ASME code boundary as shown in Figures 3.8A-16 and 3.8A-17 of the DCD, and this is in accordance with the ASME code interpretation III-2-83-01.

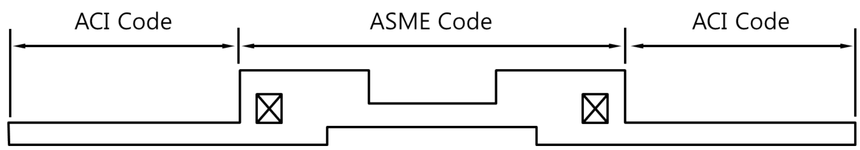

Figure 1 Jurisdictional Boundary for Design of Common Basemat

As the design criteria for the two portions of the basemat are different, the application of loads for the basemat is also divided into two parts. Figure 2 represents the application of loads based on the different code criteria. As shown in Figure 2, the load combinations provided by the ASME and the ACI codes are used in the analysis and design of the RCB and AB foundations, respectively.

Regarding the portion beyond the RCB foundation directly beneath the containment shell, the following aspects are additionally considered in the analysis and design of NI common basemat.

At the interface between the two codes, a greater amount of reinforcement required by either code is used, and the reinforcement of the RCB foundation is developed into the AB foundation as shown in Figures 3.8A-16 and 3.8A-17 of the DCD. The provisions of both codes are used to select a conservative development length.

The outside portion of the RCB foundation, i.e., the entire AB foundation area, is conservatively designed using the larger member forces from the analysis results of the ASME and ACI codes.

For the effect of the ACI load combination on the RCB foundation, the load combinations in the ASME and the ACI codes are compared. There are four kinds of loads that exist in the ACI load combination but do not exist in the ASME load combination: operating pressure, miscellaneous loads, crane and trolley load, and hydrostatic load. The operating pressure and miscellaneous loads do not have an effect on the global behavior of the basemat, and these loads are not considered in the NI common basemat analysis. The crane and trolley load is applied in the analysis as self-weight of the fuel handling overhead crane. The hydrostatic load of water storage tanks in the AB has minor effect on the RCB foundation.

In addition, the effect of the soil pressure on the RCB foundation is negligibly small because the NI common basemat has a big dimension of 348 ft x 353 ft as described in DCD Section 3.8A.2.4.1 and the distance between the RCB foundation and AB outside wall is accordingly long. Most of the soil pressure on the side walls of the AB foundation is transmitted through the AB internal walls and has little effect on the behavior of the RCB foundation.

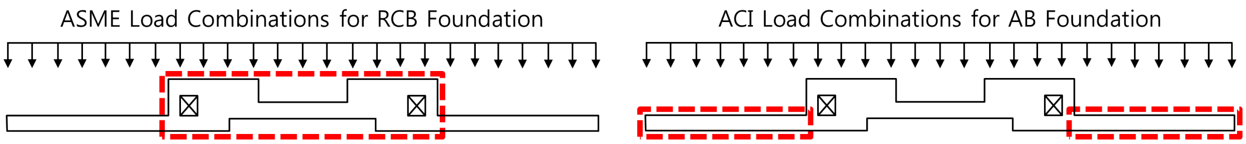

Figure 2 Application of Loads based on Code Criteria

Impact on DCD

DCD Tier 2, Subsection 3.8.1.1.2 and 3.8.5.4 will be revised as indicated in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

The general configuration and dimensions of the containment structure are shown in Figures 3.8-1 and 3.8-2. Local areas at the equipment hatch and two personnel airlock areas are thickened as shown in Figure 3.8-3.

The containment has the following dimensions:

a. Inside diameter of containment: 45.72 m (150 ft)

b. Inside height of containment: 76.66 m (251.5 ft) from the top of base slab to the ceiling of dome apex

c. Thickness of containment wall: 1.37 m (4 ft 6 in)

d. Dome thickness: 1.22 m (4 ft)

3.8.1.1.2 Foundation Basemat

A description of the foundation basemat is given in Subsection 3.8.5.

Appendix 3.8A shows the reinforcement details of the intersection where the containment wall intersects with nuclear island (NI) common foundation basemat.

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3.8.1.1.3 Containment Shell

3.8.1.1.3.1 General

The cylindrical containment shell has a constant thickness of 1.37 m (4 ft 6 in) from the top of the foundation basemat to the springline. The shell is thickened locally around the equipment hatch, two personnel airlocks, feedwater, and main steam line penetrations. The containment reinforcing consists primarily of hoop and meridional steel. Prestressing tendons are also arranged in hoop and meridional directions. The tendons in the meridional directions extend over the dome to form an inverted “U” shape.

The design basis of the NI common basemat under the RCB and the AB conform to the requirement of ASME Section III, Division 2, Subsection CC and ACI 349, respectively. The boundary of jurisdiction between the ASME and the ACI codes is shown in Figure 3.8-26. The jurisdictional boundary is placed at the thickness transition interface due to the physical configuration and functional requirements of the basemat. The anchoring of the containment shell reinforcement is limited within the ASME code boundary as shown in Figures 3.8A-16 and 3.8A-17.

~~As the design criteria for the two portions of the basemat are different, the application of loads is also divided into two parts, as shown in Figure 3.8-26. The load combinations provided by the ASME and the ACI codes are used in the analysis and design of the RCB and AB foundations, respectively. At the interface between the ASME and ACI codes, a greater amount of reinforcement required by either code is used, and the reinforcement of the RCB foundation is developed into the AB foundation as shown in Figures 3.8A-16 and 3.8A-17.~~

"deleted" (moved to DCD Section 3.8.5.4)

The reinforced concrete basemat of the reactor containment building is designed in accordance with ASME Section III, Division 2, Subsection CC. Other seismic Category I basemats of reinforced concrete are designed in accordance with ACI 349 and the provisions of NRC RG 1.142 where applicable.

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The design and analysis details for the foundations of safety-related structures are discussed in Subsections 3.8A.1.4.2, 3.8A.2.4.1 and 3.8A.3.4.1.

The maximum differential settlement of foundation is 12.7 mm per 15.24 m (0.5 in per 50 ft) within NI common basemat. The maximum differential settlement between buildings is 12.7 mm (0.5 in) based on enveloping properties of subsurface materials. In addition, the common basemat is analyzed for construction sequences to minimize any potential differential settlement during construction.

3.8.5.4.1 Analyses for Loads during Operation

The reinforced concrete foundations of seismic Category I structures are analyzed and designed for the reactions due to static, seismic and all other significant loads at the base of the superstructures supported by the foundation. The effect of the temperature load in the basemat is negligible and is not considered in the basemat analysis based on ACI 349. According to ACI 349, thermal gradients less than approximately 38 °C (100 °F) need not be analyzed because such gradients do not cause significant stress in the reinforcement or strength deterioration. In the NI common basemat, the temperature gradient is approximately 50 °F and a uniform temperature change is less than 10 °C (50 °F). The analysis of the foundation mat is performed by a three-dimensional finite element structure model, and the forces and moments determined in the analysis are input to the structural design.

The analysis and design of the foundations consider the effects of potential mat uplift, with particular emphasis on differential settlements of the basemat.

The foundation of the seismic Category I structure analysis is performed considering a soil/rock properties beneath the foundation as a nonlinear spring elements. The model is capable of determining the possibility of uplift of the basemat from the subgrade during postulated SSE events. The vertical spring at each node in the analytical model acts in

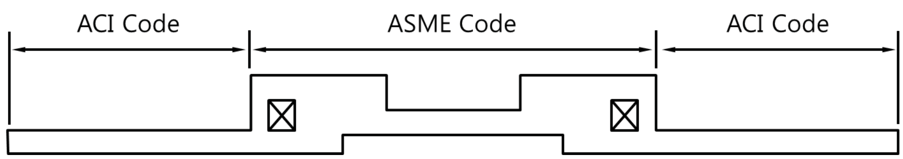
As the design criteria for the RCB and AB area of the NI common basemat are different, the application of loads is also divided into two parts, as shown in Figure 3.8-26. The load combinations provided by the ASME and the ACI codes are used in the analysis and design of the RCB and AB foundations, respectively. Regarding the portion beyond the RCB foundation directly beneath the containment shell, the following aspects are additionally considered in the analysis and design of NI common basemat.

At the interface between the two codes, a greater amount of reinforcement required by either code is used, and the reinforcement of the RCB foundation is developed into the AB foundation as shown in Figures 3.8A-16 and 3.8A-17. The provisions of both codes are used to select a conservative development length.

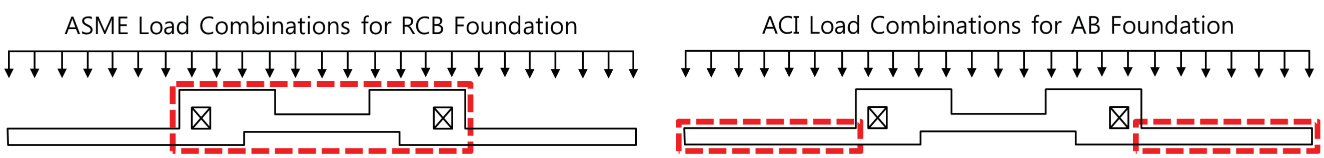
The outside portion of the RCB foundation, i.e., the entire AB foundation area, is conservatively designed using the larger member forces from the analysis results of the ASME and ACI codes.

For the effect of the ACI load combination on the RCB foundation, the load combinations in the ASME and the ACI codes are compared. Four kinds of loads that exist in the ACI load combination but do not exist in the ASME load combination are investigated: operating pressure, miscellaneous loads, crane and trolley load, and hydrostatic load. The operating pressure and miscellaneous loads do not have an effect on the global behavior of the basemat, and these loads are not considered in the NI common basemat analysis. The crane and trolley load is applied in the analysis as self-weight of the fuel handling overhead crane. The hydrostatic load of water storage tanks in the AB has minor effect on the RCB foundation.

In addition, the effect of the soil pressure on the RCB foundation is negligibly small because the NI common basemat has a big dimension of 106.0 m x 107.6 m (348 ft x 353 ft) and the distance between the RCB foundation and AB outside wall is accordingly long. Most of the soil pressure on the side walls of the AB foundation is transmitted through the AB internal walls and has little effect on the behavior of the RCB foundation.



Jurisdictional Boundary for Design of Common Basemat



Application of Loads based on Code Criteria

Figure 3.8-26 Code Jurisdiction Boundary of Common Basemat

Figure Added